

CLAIMS

1. A crystal growth method comprising a method for adding or crystallizing nitrogen in a crystal, wherein ammonium (NH_3) is used as a nitrogen source material, and aluminum is added.
2. A crystal growth method comprising a method for adsorbing a nitrogen atom on a crystal surface, wherein ammonium (NH_3) is used as a nitrogen source material, and the crystal surface includes aluminum.
3. A crystal growth method comprising a method for substituting a portion of elements in a crystal surface with nitrogen atoms, wherein ammonium (NH_3) is used as a nitrogen source material, and the crystal surface includes aluminum.
4. A crystal growth method according to any of claims 1-3, wherein decomposition of ammonium and adsorption of nitrogen on a crystal surface is accelerated by aluminum.
5. A crystal growth method according to any of claims 1-4, wherein the aluminum exists at least in an outermost

surface of a growing layer.

6. A crystal growth method according to any of claims 1-5, wherein an amount of nitrogen added to a crystal, a nitrogen composition, an amount of nitrogen adsorbed on a crystal surface and an amount of an element in the crystal surface which is substituted with a nitrogen atom are controlled based on an amount or composition ratio of added aluminum.

7. A crystal growth method according to any of claims 1-6, wherein aluminum is added to or crystallized in a restricted region, whereby only in the restricted region, nitrogen is added or crystallized, a nitrogen atom is adsorbed, or an element in a crystal surface is substituted with a nitrogen atom.

8. A crystal growth method according to any of claims 1-7, wherein a method selected among a molecular beam epitaxial (MBE) growth method, a metal organic molecular beam epitaxial (MO-MBE) growth method, a gas source molecular beam epitaxial (GS-MBE) growth method, and a chemical beam epitaxial (CBE) growth method is used.

9. A crystal growth method according to any of claims 1-8, wherein crystal growth of a III-V compound semiconductor including, as V group components, nitrogen and a V group element other than nitrogen is performed.

10. A crystal growth method according to claim 9, wherein at least one of arsenic (As), phosphorus (P), and antimony (Sb) is selected as the V group element other than nitrogen.

11. A crystal growth method according to any of claims 9-10, wherein a substrate temperature is in a range from 450°C to 640°C.

12. A crystal growth method according to any of claims 2 and 4-11, comprising a series of steps including at least steps of:

supplying a III group source material including aluminum of less than one atomic layer;

subsequently, supplying ammonium so as to adsorb nitrogen atoms of less than one atomic layer; and

supplying a source material of a V group element other than nitrogen,

wherein the series of steps are repeated one time

or more.

13. A crystal growth method according to claim 12, wherein in the step of supplying ammonium so as to adsorb nitrogen of less than one atomic layer, the source material of the V group element other than nitrogen is not supplied at the same time.

14. A crystal growth method according to claim 12 or 13, wherein crystal growth is performed over a single crystal substrate in which a {100} surface is a principal plane.

15. A crystal growth method according to any of claims 3-11, comprising a series of steps including at least steps of: forming a III-V compound crystal layer including at least one molecular layer of aluminum; and subsequently, supplying ammonium so as to substitute a portion of V group atoms in the III-V compound crystal layer with nitrogen atoms, wherein the series of steps are repeated one time or more.

16. A crystal growth method according to any of claims 3-11, comprising at least steps of:

crystal-forming a layered structure including at

least a first semiconductor layer containing aluminum and a second semiconductor layer superposed thereon;

etching the layered structure while masking a portion of the layered structure such that the first semiconductor layer is exposed in a portion of an etched surface; and

supplying ammonium to the etched surface while heating the layered structure such that at least a portion of a constituent element in the first semiconductor layer is substituted with nitrogen.

17. A crystal growth method according to claim 16, wherein the etched surface is a (n11)A surface (n=1, 2, 3,...).

18. A method for forming a semiconductor microwire structure wherein:

the crystal growth method of claim 16 or 17 is used when forming a semiconductor microstructure having a periodically-positioned wire pattern;

a diffraction grating is formed by the step of etching the layered structure while masking a portion of the layered structure such that the first semiconductor layer is exposed in a portion of an etched surface; and

a periodical wire structure is formed at a $1/2$ of the pitch of the diffraction grating by the step of supplying ammonium to the etched surface while heating the layered structure such that at least a portion of a constituent element in the first semiconductor layer is substituted with nitrogen.

19. A method for forming a semiconductor microwire structure according to claim 18, wherein the wire structure is an absorptive diffraction grating section of a gain-coupled distributed feedback semiconductor laser having an absorptive diffraction grating, or a quantum wire.

20. A semiconductor device comprising a semiconductor layer formed by a crystal growth method described in any of claims 1-18.

21. A semiconductor device according to claim 20, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

22. A crystal growth method according to any of claims 1-15, wherein a surface of the single crystal substrate is a crystal surface slanted from a (100) surface in a [011] direction (A direction) or a crystal face which is equivalent in a crystallographic sense to the slanted crystal surface.

23. A crystal growth method according to claim 22, wherein the slant angle is within a range equal to 2° or more and equal to 25° or less.

24. A crystal growth method according to any of claims 1-15, wherein one or more pairs of semiconductor layer A and semiconductor layer B are superposed, the semiconductor layer A including at least Al and nitrogen in its composition but not including indium in its composition, and the semiconductor layer B including at least indium in its composition but not including nitrogen in its composition.

25. A crystal growth method according to claim 24, wherein the thickness of each of the semiconductor layers A and B is one molecular layer or more, and ten molecular layers or less.

26. A semiconductor device comprising a semiconductor layer formed by the crystal growth method recited in any of claims 22-25.

27. A semiconductor device according to claim 26, wherein the semiconductor device is a light emitting element, and the semiconductor layer forms a light emitting layer thereof.

28. A system which uses a compound semiconductor device recited in any of claims 20, 21, 26, and 27.

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